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NASA DATA EXCHANGE STANDARDS FOR COMPUTATIONAL FLUID DYNAMICS

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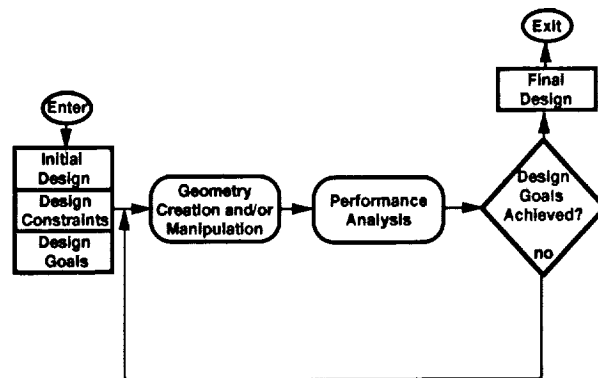
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Overview

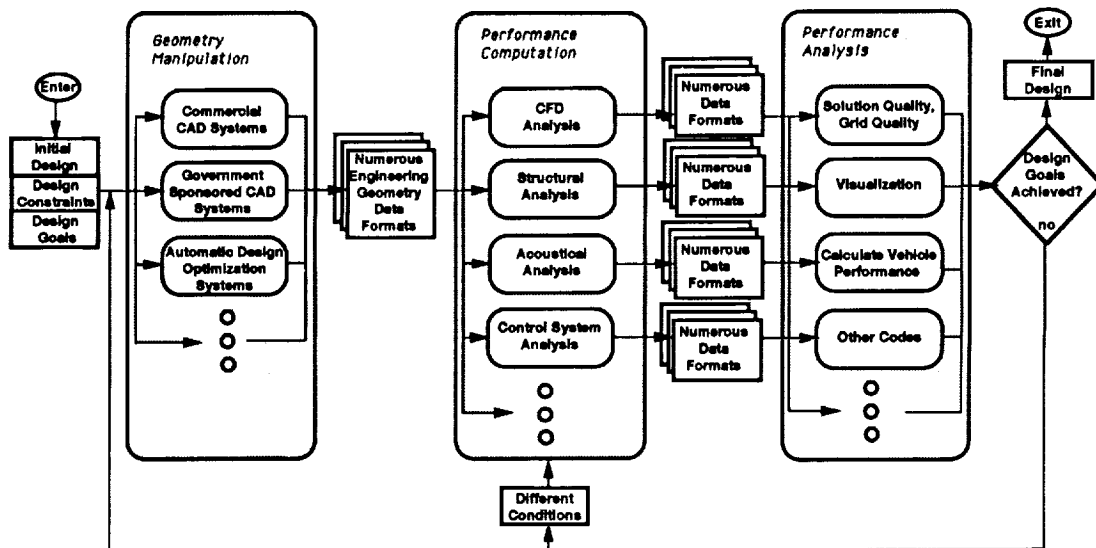
- **Purpose of Data Exchange Standards**
- **Data Exchange in Engineering Analysis/CFD**
- **Geometry Data Exchange:**
 - **Existing Product Data Exchange Standards**
 - **NASA Data Exchange Committee**
 - **NASA-IGES**
- **CFD Grid and Solution Data Exchange**
- **Data Exchange for Multi-disciplinary Engineering**

Purpose of Data Exchange Standards in Engineering

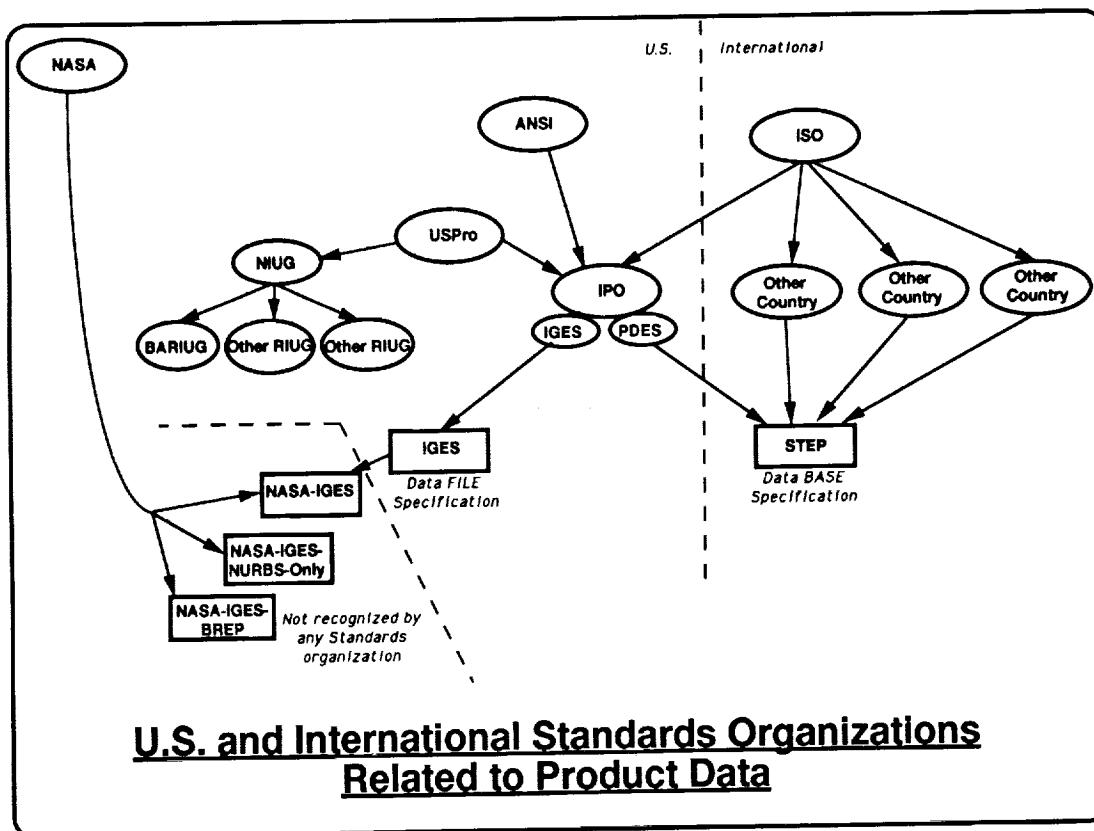
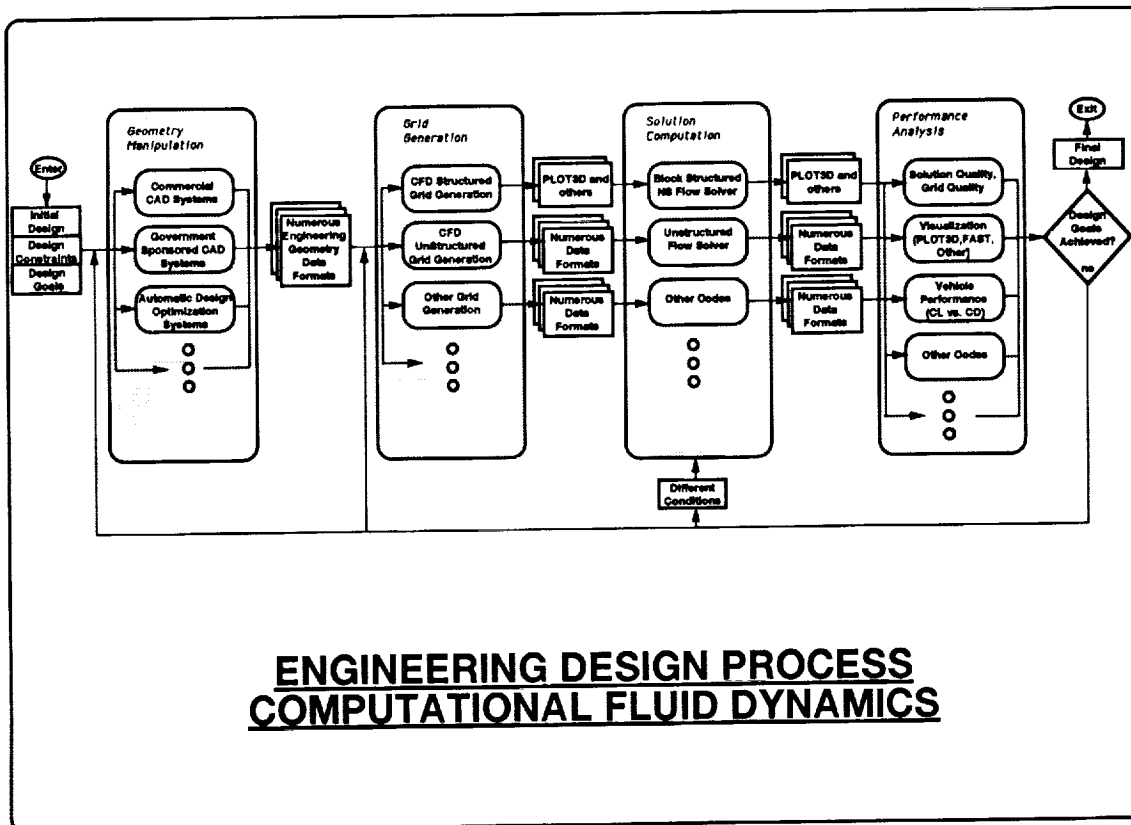
*To provide a rapid and accurate method
for exchanging data
between different engineering processes*



ENGINEERING ANALYSIS IN THE DESIGN CYCLE



ENGINEERING ANALYSIS IN THE DESIGN PROCESS



US & International Standards Organizations and Acronyms Related to Product Data

Organizations:

ISO	International Standards Organization
ANSI	American National Standards Institute
USPRO	U.S. Product Data Association
IPO	IGES / PDES Organization
PDES	Product Data Exchange Using STEP
NIUG	National IGES User Group
BARIUG	Bay Area Regional IGES User Group

Documents:

IGES	Initial Graphics Exchange Specification
STEP	Standard for the Exchange of Product Data
NASA-IGES	NASA subset of IGES
NASA-IGES-NURBS-Only:	NURBS only subset of NASA-IGES
NASA-IGES-BREP:	NURBS only geometry with B-Rrep topo. info
Superpatch	same as NASA-IGES-BREP

Other:

NURBS	Non Uniform Rational B-Splines
B-rep	Boundary Representation method for geometry topology

IGES Description

- **Currently the most widely used method for product data exchange (including geometry)**
- **Large data file specification for all product information, superset of info, many ways to represent one item**
- **Version 4.0: Supported by all(?) CAD vendors**
- **Version 5.1: Current, supported by many vendors, includes NASA-IGES entities**
- **Version 5.2: Includes Open Shell (B-rep) in "grey pages", no vendor support yet, due out middle 1993**
- **Version 6.0: Final version, due in 1994**

NASA Geometry Data Exchange Subcommittee Activities

- **Formed May, 1991, by NASA Steering Committee, includes personnel from Ames, Langley, & Lewis**
- **Surveyed CFD geometry requirements and existing geometry data exchange standards**
- **Selected a subset of IGES for CFD users**
 - **Focus is on NURBS based geometry**
 - **Added Geometry Topology Info to help automate grid generation**
- **Released draft NASA-IGES Specification on 9/30/91, final draft in October 92, NASA Reference Publication due out in 1993**

NASA Geometry Data Exchange Subcommittee Activities (cont)

- **All three Centers committed to utilizing NASA-IGES, some current activities include:**
 - **Lewis personnel developing Test Plan, test data, and code to generate NURBS from point data**
 - **Langley personnel developing and testing IGES test data**
 - **Ames personnel developing test cases and code to translate general IGES files to NASA-IGES files**
 - **All three Centers coordinate activities on a regular basis**

NASA Geometry Data Exchange Specification for CFD (NASA-IGES)

- **Written for use by CFD scientists and engineers as well as CAD vendors**
- **Includes mathematical formulation of each type of geometric representation**
- **Includes an abstract representation of the database requirements for each entity**
- **Appendix contains the IGES protocol for NASA-IGES and NASA-IGES-NURBS-ONLY**

Geometry Topology: NASA-IGES-BREP / Superpatch

- **Provides connectivity/topology information for the curve and surface geometry entities**
- **Allows grid generation software to traverse the geometry so the grid can be constructed independent of surface layout choices made by the original designer**
- **Supplies important information for development of automated grid generation software**
- **Similar to Boundary Representation (B-rep) solid modeling technique**

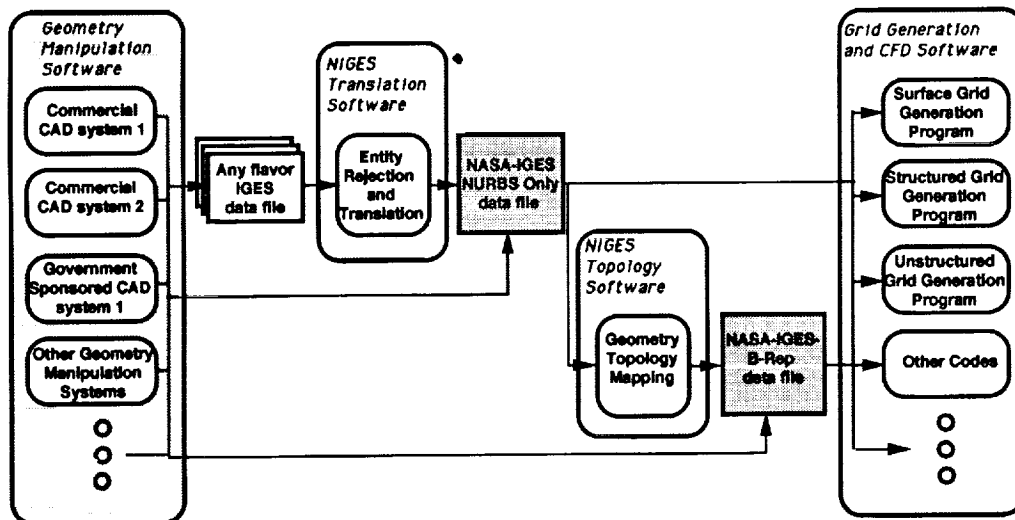
NASA-IGES ENTITIES

- **NASA-IGES-NURBS-ONLY Geometry Entities:**
 - Entity 126: Rational B-Spline Curve
 - Entity 128: Rational B-Spline Surface
 - Entity 141: Boundary
 - Entity 142: Curve on a Parametric Surface
 - Entity 143: Bounded Surface
 - Entity 102: Composite Curve
 - Entity 124: Transformation Matrix
- **Other Geometry Entities Allowed in NASA-IGES:**
 - Entity 100: Circular Arc
 - Entity 104: Conic Arc
 - Entity 106: Copious Data
 - Entity 110: Line
 - Entity 116: Point
- **Non-Geometry Entities:**
 - Entity 0: Null Entity
 - Entity 212: General Note
 - Entity 308: Subfigure Definition
 - Entity 314: Color Definition
 - Entity 402: Associativity Instance
 - Entity 406, Form 15: Name
 - Entity 408: Singular Subfigure Instance

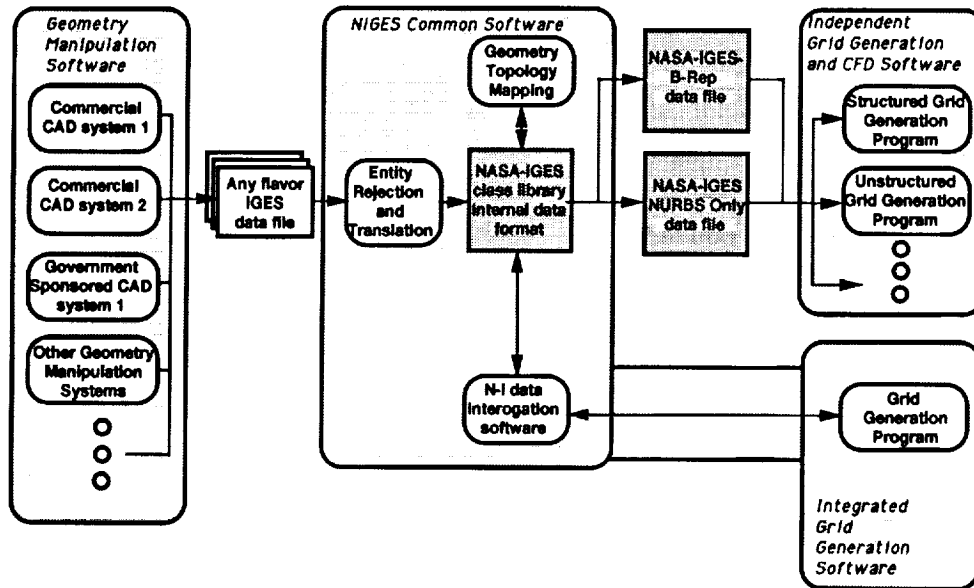
NASA-IGES-BREP ENTITIES

- **Topology Entities:**
 - Entity 186: Manifold Solid B-Rep Object
 - Entity 514: Shell, Closed and Open
 - Entity 510: Face
 - Entity 508: Loop
 - Entity 504: Edge List
 - Entity 502: Vertex List
- **Geometry Entities:**
 - Entity 126: Rational B-Spline Curve
 - Entity 128: Rational B-Spline Surface
 - Entity 102: Composite Curve
 - Entity 124: Transformation Matrix
- **Non-Geometry Entities:**
 - Entity 0: Null Entity
 - Entity 212: General Note
 - Entity 314: Color Definition
 - Entity 402: Associativity Instance
 - Entity 406, Form 15: Name

CFD Geometry Data Exchange Utilizing NASA-IGES and NASA-IGES-BREP Data Files



CFD Geometry Data Exchange Utilizing NASA-IGES and NASA-IGES-BREP Data Files and Class Library

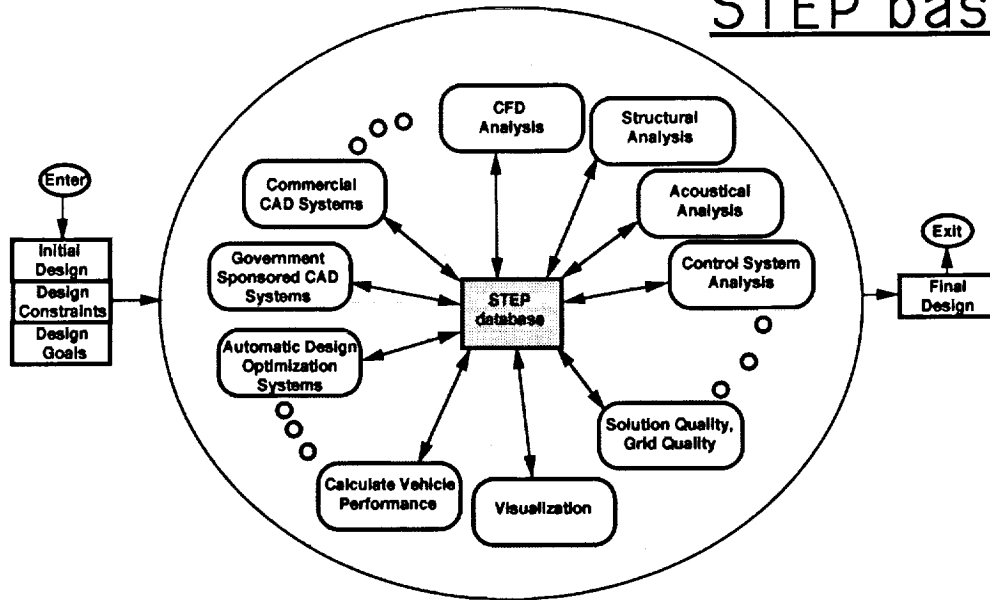


CFD Grid & Solution Data Standards: Design Goals

- **Include enough information to reconstruct connectivity information used by any specific application**
HELP>>> Fill in the supplied table or provide documentation of your grid & solution data requirements
- **Insure reasonable space efficiency:**
 - **Disk space vs. ease of use**
HELP>>> My calculations show Unstructured Grid Formats require 10 - 20 times the storage space of structured. If you disagree, describe your assumptions and calculations
- **ASCII vs. binary**
HELP>>> Why stick with ASCII? IEEE binary?

HELP>>> Structures, Controls, Thermal, ????

STEP based



DATA EXCHANGE FOR MULTI-DISCIPLINARY ENGINEERING ANALYSIS

How To Help (or Get Help) on NASA Data Exchange Standards

- To get on the email forum for Grid Generation contact:
siggrid-request@nas.nasa.gov (or my email below)
- To get a draft copy of the "NASA Geometry Data Exchange Specification for CFD" (NASA-IGES) contact me
- To assist with Grid & Solution Data Exchange Standards, fill out a data requirements sheet for your software (available at the back of the room) or provide documentation of your requirements, send to me
- **Matthew Blake**
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